

The DREAM2 (Dynamic Response of Environments at Asteroids, the Moon and moons of Mars) program is currently analyzing the effects of proton implantation and OH creation/retention in lunar soils and minerals as a function of temperature, defects and irradiation. The new beam line at NASA GSFC Radiation Effects Facility (REF) has been constructed and coupled to a UHV surface science chamber. For these analyses, lunar soils are compressed into a pellet, and exposed to a low energy 0.1-5 keV hydrogen ion beam to simulate solar wind irradiation. These results are being compared to data from pretreated pellets that have undergone high energy 1 MeV particle irradiation immediately beforehand in the same apparatus to determine how simulated solar energetic particles affect implantation and retention. The exposure rates are varied from 10^{13} particles/cm² to 10^{18} particles/cm². The lunar soils analyzed represent a variety of maturity and mineral types. Samples 12001 and 72501 have been shown to have differences in water binding energies (Poston 2015). Samples 62241 and 70051 have evidence of proton-induced hydroxylation and exchange of soils (Ichimura 2012). For soil samples 15271, 73131, and 78421, current studies are being performed to determine binding energies for various volatiles which will complement this study, Lunar Sample Request #2993.

In addition, laser induced thermal desorption measurements will be used to determine total volatile content. The thermal stability of water and/or hydroxyls will be performed in a vacuum tube furnace coupled to a QMS. The soils in these experiments are exposed to cycles of heat and various concentrations of liquid/gaseous H₂O and D₂O. The thermal cycling measurements will be monitored via mass spectroscopy and diffuse reflectance FTIR termed DRIFTS and mass loss, and are complementary to the irradiation experiments for understanding the band positions and depths of various concentrations of hydroxylation as a function of temperature, concentration, and band position. BET analysis of select samples will be performed before and after thermal cycling to determine the effects on pore size and effective surface area.

Several studies have indicated that at simulated solar wind energies, lunar soils and minerals can become hydroxylated, Ichimura 2012, Schaible 2014, and references therein. With this set of experiments, we will be able to determine if simulated solar energetic particles significantly alters the hydroxylation reaction and spectral properties of the lunar soils. With the combination of the thermal cycling technique, H₂O and OH signatures will compliment several studies including Milliken 2005, and provide insight into the wealth of spectral data from M3, LRO, Dawn, Chandrayaan-1, and upcoming Lunar missions.